ERIKA E. SMITH AND RICHARD HAYMAN

10. DECISION MAKING AND PROBLEMS OF EVIDENCE FOR EMERGING EDUCATIONAL TECHNOLOGIES

To support what is commonly referred to as twenty-first century learning, those in decision-making roles are often urged to quickly adopt and integrate the newest educational technologies and abandon older processes—or risk becoming obsolete. This impetus to quickly adapt can be witnessed in the discourse surrounding the impact of technologies in today's educational landscapes. The past decade has been witness to considerable discussion regarding the purpose and value of educational technologies, especially regarding the potential of e-learning to "transform" learning in the twenty-first century. Those in favour of these innovations, such as Garrison and Anderson (2003), believe that "E-learning will inevitably transform all forms of education and learning in the twenty-first century… E-learning cannot be ignored by those who are seriously committed to enhancing teaching and learning" (p. 2). As such, many technology advocates see the choice as no longer concerning *if* technologies should be used, but rather *what* and *how* technologies will be implemented in the learning environment. As some argue, "Universities no longer have a choice about whether to implement e-learning: they must in order to remain competitive in the market place … E-learning is now at the heart of a university's core business of learning and teaching" (Kregor, Breslin, & Fountain, 2012, p. 1382).

Related to this discussion of educational transformation via technologies around the turn of the twenty-first century, various depictions of the *Net generation* or Millennials as "digital natives" (Prensky, 2001a, 2001b; Tapscott, 1998, 2008) emerged. Digital natives are purported to: (a) be native speakers of the language of technology; (b) learn differently from preceding generations of students; and (c) demand a new way of teaching and learning involving technology (Thomas, 2011, p. 4). Digital native proponents have been criticized for presenting a problematic utopian vision of technology that is tied to an exoticized picture of liberated young people (Buckingham, 2011), with critics arguing that such popular claims regarding the Net generation as digital natives are largely unsupported by substantive research evidence. Such critics contend that, rather than being theoretically or empirically informed, such kinds of discourse about educational and technological transformation and, relatedly, the debates regarding the needs of digital native students, equate to a form of "moral panic" that restricts critical and rational consideration

P. Newton & D. Burgess (Eds.), The Best Available Evidence, 147–166.

(Bennett, Maton, & Kervin, 2008; Smith, 2012, 2013). Indeed, similar tropes defining a crisis in education, as we will see in the following paragraphs, can be witnessed in the paradigms informing debates on evidence-based education as well (Pirrie, 2001). As a result, there is a need to revisit and perhaps redevelop approaches that enable research-informed decision making regarding emerging technologies in our educational settings.

With the ever-expanding range of emerging educational technologies that could be introduced to learning environments, making evidence-informed decisions about whether and how to effectively use e-learning tools for pedagogical purposes is a critical yet challenging task. How can educators, learners, and administrators make informed decisions about the use of particular emerging technologies to achieve desired pedagogical transformation when, due to their relative newness, there is often a perceived lack of available and "up-to-the-minute" research on the latest technological trends that may impede evidence-based educational practice? This is a key problem of evidence for technology use in higher education.

This chapter discusses several exigent problems of evidence for decision making regarding emerging technologies, particularly for higher education, beginning with a brief overview of evidence-based practice (EBP) and twenty-first century learning. We reflect upon strategies that educational practitioners may employ when facing a perceived lack of up-to-date evidence to support their decision-making processes. By discussing strategies for identifying affordances and employing environmental scanning, we describe approaches for mitigating potential research gaps when considering use of emerging technologies within academic learning contexts.

EMERGING EDUCATIONAL TECHNOLOGIES IN THE TWENTY-FIRST CENTURY

Notions of teaching and learning in the twenty-first century involve many diverging views on and visions of the future of education. However, within this range of views, a key recurring theme is the need to integrate technology and education effectively and beneficially in the new century (Brown, 2006; Brown & Adler, 2008; Garrison & Anderson, 2003). Illustrative of such discussions, Wan and Gut (2008) asserted the following:

> In many ways, new media and information are already changing the way that we learn and teach in the new century. The field of education is faced with the challenge of redefining teaching and learning to adapt to a rapidly changing world and what it means to be a teacher and a student. (p. 175)

In this environment, technology proponents assert that such tools change learning and should be woven into an interactive and responsive learning space, such that the virtual classroom is just as important as the physical one. Together, these inform an institutional context where constant *connectedness* has become so commonplace that it is often seen as being inseparable from the twenty-first century learning

environment itself (although here we prefer the term connectedness, for alternative discussions of *connectivism*, see Siemens, 2005). Today, educators and learners experience education not just through the face-to-face classroom, but also via hardware and networking infrastructures, learning management systems, social media, mobile devices, and Internet ubiquity.

Emerging Technologies

Coupled with this focus on transforming learning via an information revolution happening in the twenty-first century, a core conundrum of the term *emerging technologies* is that it is often misunderstood and remains ill-defined despite its frequent use. Broadly, emerging educational technologies can perhaps be understood as "tools, concepts, innovations, and advancements utilized in diverse educational settings…evolving organisms that experience hype cycles…not yet fully understood, and not yet fully researched" (Veletsianos, 2010, pp. 3–4). Even though they are still in a developmental stage of design and production, emerging technologies are often seen as inherently strategic, in that they are tied to aspirations, investment, planning, and thinking about the future (Einsiedel, 2009).

With this future-looking lens, and reflecting views similar to the e-learning thinkers already mentioned, emerging technologies experts typically focus on tools that will be "revolutionary" or that alter traditional relationships and cause social disruption. For example, technologies that will have broad impacts on day-to-day life, just as historically the automobile, and more recently the Internet and World Wide Web, dramatically reshaped the known world (Einsiedel, 2009, pp. 3–4). Given this future-looking and aspirational focus of those concerned with emergence, a key challenge surrounding research and policies for such technologies in education, then, is contextualizing and applying relevant knowledge that can be used today and in the future, and which will not become quickly out-dated.

Convergence

Amidst all of these discussions of technological emergence, to make sense of the problems facing those in decision-making roles today, there is great potential in the notion of the *converging technologies* as understanding the evolving qualities, integrations, and merger of such tools. According to McLuhan (2002), changes in pattern or interaction are of utmost importance: "the 'message' of any medium or technology is the change of scale or pace or pattern that it introduces into human affairs" (p. 8). The idea of emerging technologies as related to convergence underscores the fact that many technologies we use have evolved and been synergized in a unifying way (Kaldis, 2010), building upon and integrating the qualities of previous technologies. From another standpoint, media convergence may be understood as "the flow of content across multiple media platforms, the cooperation of multiple media companies, and the migratory behaviour of media

audiences" (Jenkins, 2006, p. 2). As such, these technological or media patterns and scale changes can be seen as the message.

An example of the convergence of emerging technologies is Google Apps (increasingly used in educational settings), which now combines the traditionally separate features of email with amalgamated features of calendars, documents, and talk (voice over IP and chat), and further enhanced by online storage and cloud software (e.g., for document creation and sharing), to name a few. Another example can be seen in social microblogs such as Twitter, which has combined previously discrete forms of short message service (SMS), really simple syndication (RSS) feeds, direct messages (DM), and weblogs (or blogs), all within a micro 140 character setup. Finally, convergence may be seen in the increasing prominence of a platform across other technologies; for instance, the increasingly common option to use one's Facebook, Google+, or Twitter account to login and connect to other third-party social networking applications, such as Pinterest or Academia.edu. This synergy, unification, or merging of technologies can be a critical point of consideration when searching for evidence, particularly for those who use technology in their educational practice, and one to which we will return in our case study.

Emerging web technologies are increasingly used in academic learning environments, and include a host of social media tools, such as blogs, wikis, instant messengers (IM), social bookmarks, podcasts, and vodcasts (Saeed, Yun, & Sinnappan, 2009). Willcockson and Phelps (2010) provided a useful overview of emerging technologies, in which they list many social media and web-based technologies, but also include serious games and virtual worlds. Recent editions of the New Media Consortium's annual *Horizon Report* (Johnson et al., 2013; Johnson, Adams Becker, Estrada, & Freeman, 2014, 2015) have outlined key emerging technologies that they assert will impact higher education in the next five years, including ubiquitous social media, massively open online courses (MOOCs), tablet computing, games and gamification, learning analytics, 3D printing, makerspaces, and wearable technology. In addition to these sources, and within higher education specifically, information on trending emerging technologies is easily discoverable via the *ECAR Study of Undergraduate Students and Information Technology* (see EDUCAUSE reports, e.g., Dahlstrom, Walker, & Dziuban, 2013; Dahlstrom & Bichsel, 2014), not to mention various conferences, journals, magazines, and blogs all interested in detailing new developments in educational technologies. Notably for higher education, current discussion about transformation and disruption has centred to a large extent on MOOCs, a topic with widespread media coverage that is debated as either a revolutionary game-changer (Leckart, 2012) or as an over-hyped and problematic venture (Schuman, 2013).

EVIDENCE-BASED PRACTICE IN EDUCATION

As the diversity of chapters included in this publication illustrates, ways of using the best available evidence in education are much discussed, and there are many

perspectives on the process and constitution of evidence-based practice (EBP) and decision making for educational contexts. We can see that relating research evidence and practice is, unsurprisingly, an important focus for many professional areas. Evidence-based practice has fully emerged in disciplines such as education, health care (as illustrated by journals such as *Evidence-Based Medicine*), and library and information sciences (for further discussion of evidence-based decision making in professional library contexts, see Hayman & Smith, 2015). These fields have influenced one another in their definitions of evidence-based practice, and so while EBP is intended to have specific disciplinary and professional application, EBP should be understood broadly as an overwhelmingly interdisciplinary and interprofessional concept. Furthermore, the overlap between evidence and practice within these disciplines reflects the relationship between research and education as concomitant endeavours involving the discovery and application of new forms of knowledge for societal and individual betterment. Clearly, this relationship is especially relevant to universities whose mandates reflect research-teaching relationships through educational programs at the undergraduate and graduate level, and who are increasingly involved in lifelong learning and continuous professional development programs.

Within discussions of evidence-based education, proponents argue for transformation through increased incorporation of evidence in education to better inform policy and practice. For instance, Slavin (2002) saw great promise in an EBP "scientific revolution" that will change education with a "focus on rigorous experiments evaluating replicable programs and practices" (p. 15). Similarly, Davies (1999) argued for an increase in evidence-based approaches that involve utilizing and establishing high-quality research (systematic reviews and meta-analyses, often relying on scientific means and criteria), to inform a set of principles and practices that enhance and support professional judgment in the field. Davies (1999) explicitly noted crossover between these characteristics of evidence-based education and those in evidence-based healthcare, and likewise Slavin (2002) drew direct connection to medical interventions and experiments. Such approaches to evidence-based education have been taken up with goal of improving policy and practice; for example, through initiatives such as the Best Evidence Encyclopedia (http://www.bestevidence.org/) created by the Johns Hopkins University Center for Data-Driven Reform in Education.

Several criticisms have been levelled against such approaches to EBP in education, including the strong relationship to scientific and quantitative strategies at the exclusion of other approaches. For example, in response to arguments from thinkers like Slavin (2002) who advocate for a prescriptive or replicable "what works" approach to education, Olson (2004) proposed that we must examine critically the underpinning "beliefs, goals, and intentions of those supposedly affected by the treatments" (p. 24) offered. Other critics, such as Pirrie (2001), point out that these arguments reflect a form of "moral panic" that precipitates an inflated "crisis of legitimation" (p. 124) underscoring the rationale for transformation, a stance similar

to that presented by Bennett, Maton, and Kervin (2008) in response to problems of evidence within the digital native debate. What these critics present is a concern about the limited range of methodologies and toolkits (i.e., those solely reflecting scientific or instrumental paradigms) accepted as a part of evidence-based education. Such points underscore the need for critical acknowledgement that research and education should not and cannot take a context-free, one-size-fits-all-approach.

It is our view that, by being reflexive about these issues, educators conducting research-informed EBP can intentionally take into account a wider range of paradigms, methodologies, and strategies in ways that avoid unnecessary prescription. One way that we may do so is by leveraging emerging frameworks that articulate relational aspects of practice. Such flexible frameworks, as we outline in more detail below, can also include approaches to environmental scanning and identifying aims and affordances that may widen the available sources of useful evidence. In recognizing both the benefits and limitations of an evidence-based approach, we can balance the value of evidence-informed decision making with the need for contextualized practice.

PROBLEMS OF EVIDENCE FOR EMERGING TECHNOLOGIES IN EDUCATION

As the preceding discussion suggests, discovering information on the features of new technologies themselves is relatively easy given the variety of sources describing and forecasting technology trends. However, when little is known about these technologies in practice, such as how tools in production interface with existing technological infrastructures, policies, and processes, there still exists a significant challenge: how do we make informed decisions regarding if, where, and when new technologies should be incorporated into our teaching and learning environments? This is the crux of the evidence problem at hand: when it comes to any given emerging technology, where there is a perceived lack of substantive up-to-date research regarding its educational use, value, and impact on pedagogy, how can we address potential barriers and support evidence-based decision-making models?

Wicked Problems

Facing the challenges outlined above, decision makers may see the development of theoretical and empirical evidence that informs use of emerging technologies in practice as unavailable, or perhaps as too slow or unrealistic, given the ever-changing and evolving nature of such innovations. As the nature of these issues are seen to be complex and constantly changing, it can be helpful to understand decision making and planning related to emerging educational technologies as an *unstructured* or *wicked* problem.

Particularly relevant to planning and policy development, *wicked problems* were first defined by Rittel and Webber (1973) as those societal issues that differ from

problems of math and science precisely because they do not have clear true-false answers. In other words, finding "one-best answer" is impossible with wicked problems, as they do not have a definitive formulation or solution. As a result, rather than searching for value-free or "true" answers, with wicked problems the (social) context must inform meaningful and iterative judgment of information to resolve, rather than solve, the items at hand (Rittel & Webber, 1973). Furthermore, there is no opportunity for trial-and-error testing of the proposed solutions to wicked problems, for all implementations and decisions (or, attempted reversal of decisions) will have real-world impacts and consequences that cannot be undone. As Rittel and Webber argued with an example from education, the "effects of an experimental curriculum will follow the pupils into their adult lives" (p. 163). Along these same lines, *unstructured decisions* are seen as those "decision processes that have not been encountered in quite the same form and for which no predetermined and explicit set of ordered responses exists in the organization" (Mintzberg, Raisinghani, & Théorêt, 1976, p. 246). As we have seen, the characteristics of wicked problems and unstructured decisions can be witnessed in discussions regarding the conundrum of emerging technologies and their educational impact.

It is useful to understand the issues surrounding decision-making for emerging educational technologies through the lenses of unstructured or wicked problems and EBP in education, since there is often an articulated concern about quickly adapting to technological innovations that have not been encountered in the same form and for which there is no pre-set response. Rather than searching for the "one-best answer" or looking for "the best evidence" or even "best" solutions or practices to follow as we encounter wicked technological and educational problems, it is instead more useful to consider approaches to the meaningful and iterative judgment of high-quality information within our social and educational contexts.

Identifying Problems of Evidence

While several problems of evidence exist regarding emerging educational technologies, in this chapter we focus on what we have come to understand as a perceived lack of new "up-to-the-minute" research on evolving technological innovations. Through our own professional practice working in technology-enhanced education settings, this is a concern we face regularly in our own educational roles, and one that we regularly see in our consultations with other academics and educators. In seeking to effectively adopt emerging technologies, this perceived lack of evidence leads to a potentially dichotomous position. Must we: (a) quickly adopt emerging technologies without applying the evidence, therefore falling short of a true research-informed decision-making process, or else (b) delay the adoption cycle until evidence exists, in the form of educational research, but risk missing opportunities for innovation and being seen as out-dated due to the delay in time-to-adoption? If the problem is presented to us in this manner, as is so frequently the case, then there is no ready solution and no clear answer.

However, we argue that several approaches can be used to identify and mitigate such problems of evidence, approaches that do not limit us to these dichotomous options. Even though new and emerging technologies can (and do) shape practice, a lack of formal research around a particular new technology does not mean there is no useful evidence base of information to be found. The following discussion outlines the complementary approaches of identifying aims and affordances, along with environmental scanning, and we argue that these methods can be used to recognize and address the perceived lack of traditional evidence available for effectively incorporating new technologies into practice.

APPROACHES TO INFORMED DECISION MAKING REGARDING EMERGING TECHNOLOGIES

When implementing emerging technologies, there are a variety of possible methods one can use to address the problem of evidence. In this section we highlight two tried-and-tested methods: identifying aims and affordances, and the information seeking environmental scan. We then use a case study to highlight how these two methods can be applied in an academic environment for practical results. And while it makes sense to identify affordances before the conducting the environmental scan, we are not suggesting that this is a rigid, step-by-step process. Ultimately, we propose that these are complementary methods that are relational in nature and should be used in tandem, so that each iteratively informs the other.

Identify Aims and Affordances

When facing a lack of up-to-date evidence on a specific new technology, it is often helpful for practitioners to (re)focus on the aims and affordances related to the questions and problems at hand. Willcockson and Phelps (2010) called this focus "keeping learning central," and make sound recommendations for examining the learning theories, learner characteristics, and instructional goals when determining whether or not to use an emerging technology. This may include determining items of theoretical or philosophical importance. As Kanuka (2008) aptly demonstrated, we can best understand technologies in practice by first understanding our philosophies in practice, to avoid simply following the latest trends by taking time to ask *why* what we are doing is important. There is a range of helpful literature and empirical experiences to draw upon regarding pedagogical strategies and philosophical underpinnings that can support and align to the educational goals in mind and inform use of a particular technology.

When implementing emerging technologies for education, Willcockson and Phelps (2010) recommended finding the connection between the *affordances* of the technology being considered for implementation and the learning problem, objective, or goal it is hoped the technology will address. They defined an affordance as "the way a technology or software can be used and what it allows the user to do

or not to do" (para. 9). In other words, an affordance is the characteristic that allows (or disallows) one to carry out an action within an environment or via an object. In our physical environment, an example of an affordance is a knob that can be twisted, or an elevator button that can be pressed. In the virtual world an example of an affordance is an on-screen button that the user can click or touch when using a mouse or trackpad or touchscreen, i.e., the button affords clicking. Willcockson and Phelps provided multiple examples of affordance-learning goal matching, such as using a wiki to meet the outcome of providing students an online mechanism to collaborate on content creation, or establishing student blogs to create opportunities for reflective learning via journaling (para. 10).

The idea of affordances has influenced a number of fields, including industrial design, human-computer interaction, and instructional design. In designing learning interactions for the physical or virtual environment, we can leverage the notion of affordances to make informed choices that can enhance optimal aspects or reduce sub-optimal ones. For example, certain affordances of educational media or e-learning technologies may be designed to enable optimal presentation, engagement, or interaction with material (e.g., via graphics, text, sound, etc.), and when used according to design principles can aid in comprehension (see, e.g., Clark & Mayer, 2011; Mayer, 2005). By considering affordances or the properties of learning environments and objects, educators can use instructional design to meet goals, and to make informed choices about the selection and use educational technologies. They can intentionally design learning objects that use media features, for instance, to promote learning, to reduce cognitive load, and ultimately to help learners achieve the intended learning goals (Rabinowitz & Shaw, 2005, p. 51). Perhaps most importantly, educators and decision makers can endeavour not to simply forecast technological trends, but to observe and forecast changes and patterns of interaction between learners, their environment, and the content.

Speaking generally, to connect pedagogical goals with affordances, we suggest conducting a literature review or evidence search that seeks other implementations of comparable pedagogical outcomes achieved with similar technologies (or similar affordances), to understand the pedagogical and technological impact in situations akin to the one at hand. During this evidence search the guiding questions may change, for instance, from "How can I use this emerging technology in my teaching?" to "How can I design learning, given the affordances available, to meet this pedagogical goal?" However, it is important to remember that the affordances discovered within technologies, whether emergent or long-standing, do not necessarily inherently lead or connect to learning outcomes. As Day and Lloyd (2007) argued, it is important to recognize that affordances should be understood as "products of a whole learning context, of which online [and other] technologies are an integral part, rather than being inherent properties of the technologies in isolation from the context in which they are used" (p. 20). When we recommend identifying affordances to inform decision making when facing a problem of evidence, it is this more broad perspective we envision, a perspective

that accounts for one's proposed learning outcomes, learning environment, and learner characteristics.

The importance of discussing affordances with regard to decision making for emerging educational technologies here comes back to our earlier point that an evidence base must be contextualized to the learning goals and outcomes intended. After identifying learning goals and affordances within our educational setting, objects, and materials, we can then create an evidence base by searching for and utilizing existing research literature and empirical observations on similar goals and affordances. Thus, rather than simply focusing on a current technological trend or on a newly launched innovation in isolation, there can be a focus on learning from research on, and experiences with, pedagogical goals and affordances that have existed and perhaps evolved or converged over time. When we critically examine whether these characteristics or features can enhance or subvert our intended educational purpose, we can make informed decisions about how best to work within the constraints of our circumstances to achieve the desired educational results. If we adhere to the argument that there exists no one-size-fits-all approach to making evidence-based decisions that will work for every circumstance, then looking at goals and aligning the intended outcomes with appropriate affordances becomes a powerful way to find and refine useful information from similar areas that will hold relevance.

Although emerging technologies are often perceived to be so revolutionary and new that no formal research around their use exists, it is important to emphasize that often these technologies build upon and incorporate lessons learned and information from publications and empirical observation of established features, functionalities, and affordances. There is a well-established body of literature on educational strategies, instructional design, and e-learning that can be leveraged when one has identifiable pedagogical outcomes and affordances in mind, regardless of whether a particular trend or theme is at play. Thus, we recommend that practitioners seeking an evidence base should look for recent implementation of similar affordances or features that may have converged across similar, related technologies, rather than focus on the one specific technology under consideration. For example, someone who is considering whether to implement Google Talk for synchronous chat- and text-based communication in a distance education setting may consult existing research on chat and talk tools within learning management systems, or within older or established technologies like Skype and MSN Messenger. Consulting existing research on converging technologies with similar characteristics that reflect the particular learning goals to be met through implementation is one recommended method for addressing the problem of evidence.

Environmental Scanning

When faced with an important decision around adoption of a new technology, particularly in situations where technology integration is deemed to be required, but where formal, specific evidence is perceived to be lacking, the use of *environmental*

scanning is a tried and tested method of information gathering. Many post-secondary institutions and other organizations do this as part of a strategic and often future-looking planning process (Gibbs, 1996; Grummon, 2012). In many respects, the aforementioned *ECAR Study* and the *Horizon Report* both use environmental scanning as the foundation for their reporting.

Environmental scanning takes many forms depending on the discipline or focus of the scan, and there are various definitions and types depending on the need and anticipated outcome. From an information-gathering standpoint, the activity of scanning the environment can perhaps best be understood as the "acquisition and use of information about events, trends, and relationships in an organization's external environment, the knowledge of which would assist management in planning the organization's future course of action" (Choo, 2001, para. 1). Further to this definition, Chrusciel (2011) defined an environmental scan as a crucial part of the strategic planning process for organizations, particularly for identifying quality of service, customer expectations, and anticipating future needs. However it is worth noting that an environmental scan itself must be more than just an exercise in information gathering, and that the resources must be assessed for applicability to one's situation and context. As Zhang, Majid, and Foo (2010) concluded, the environmental scan requires important information literacy skills that involve the evaluation and use of the information discovered, and connecting that use to the intended outcomes.

Though discussions of environmental scanning are often framed within a managerial or organizational planning lens, we believe that an understanding of these activities should be expanded to include educational practitioners across all levels of the institution. The ES can be conducted by undertaking information-gathering, observation, and experimentation with technologies. In this way, environmental scanning and information gathering activities can help in constructing shared knowledge-bases via networks, within communities of practice (Wenger, 1998) and communities of inquiry (Garrison, Anderson, & Archer, 2000, 2010), both inside and beyond an individual's own institutional systems.

To put it simply, when it comes to decisions around new technologies, creating an evidence base may be realized by establishing an *empirical foundation* using a range of strategies that incorporate the experiences, observations, and experimentation done by others. This is not to devalue the literature review process, which is an essential undertaking, but rather underscores the importance of going beyond the extant research literature during the information gathering process, especially when faced with an initial dearth of recorded evidence. As Alderman, Towers, and Bannah (2012) described in their study on student feedback mechanisms, "although the main emphasis is on sources demonstrating evidence-based research supported by sound theoretical underpinnings, other relevant resources such as observational studies, reports and conference papers are also taken into account" (p. 262) to inform their research.

When engaging in decision making with respect to putting new or unfamiliar technologies into practice, we recommend information seeking via Internet

searching, one of the most common forms of environmental scanning. The ES may incorporate readily accessible (public) websites and news sources, along with sometimes hard to discover reports, white papers, and other informally published resources traditionally classified as grey literature. The kinds of resources discovered for the ES may depend on the type of technology and pedagogical setting that is the subject of the scan, and naturally there are limits to this type of scanning. For instance, Internet scanning success can be hit-or-miss depending on whether one's selected search terms match against indexed metadata recognized by the search engine being used. Moreover, typically this type of scan will not successfully discover material in the Deep Web, such as material behind a password-protected portal (e.g., an institution's employee-only intranet or LMS), potentially missing key resources that would be helpful for constructing a more fulsome evidence base. Nevertheless, to address the problem of evidence this type of scanning is still useful.

Increasingly, social media applications and online social networks can further aid in environmental scanning. For instance, Academia.edu provides not only availability of some online resources, but also provides connections to a community of researchers and practitioners with whom one may discuss issues of interest. Tools for community building, such as online forums and online news sources, may also prove useful for connecting with a community of academics, practitioners, or other user groups also in the midst of exploring similar questions and issues. Of course, ethical and privacy issues may limit the availability or effectiveness of information shared in online contexts, however it is not within the scope of this chapter to discuss those items in detail. Ultimately, the scanner must then account for the credibility and utility of these resources through applying information-literacy skills, and then determine how these examples can be applied and contextualized within their own scenario.

In regards to both strategies of identifying aims and affordances and conducting an environmental scan, clearly each approach should inform the other as decision makers refine their own understandings and make sense of the available evidence related to pedagogical aims and outcomes, as well as technological features and affordances. As a wicked problem, the challenge of finding evidence for emerging educational technologies may be mitigated by refocusing on the purpose and characteristics of the pedagogical and technological items at hand.

CASE STUDY: IPADS IN AN ACADEMIC LIBRARY

At this juncture, an example of early adoption of an emerging technology in a practice-based pedagogical setting is useful. Our case study involves the 2010 launch of the Apple iPad, which generated immediate educational interest at the time of release while also maintaining ongoing relevance for today's educators. It is worth noting that there are multiple other emerging technology examples we could have selected to make this case, but at nearly 94% of the market share for tablet products for education as of late 2013 (AppleInsider, 2013; Cheng, 2013), the dominance of

iPads in education make it a highly relevant example even today. The case study is built from one author's direct experience implementing iPads in an educational setting shortly after the device appeared on the market, and therefore provides first-hand insights into ES strategies and implementation issues faced with this particular emerging technology.

Case Study Background

While upon release the iPads received a lot of attention from academic communities, it should come as no surprise that at that time there was no available academic research on successful implementation of this specific iPad technology in an educational setting. The problem of a lack of evidence in this case is a striking example of how the impetus to quickly adopt a new and emerging technology poses immediate challenges. With no iPad-specific evidence to consult to assess what kind of pedagogical impact would emerge when students began taking the devices into their classrooms, let alone how to address the logistical challenges of ensuring access, keeping the devices secure, and providing a support mechanism for users, those seeking to implement iPads in their learning environments required alternative evidence gathering opportunities.

In 2010, a medium-sized undergraduate university in Alberta, Canada looked to implement an iPad-lending program through the library. The iPads were made available to all members of the university community via a sign-out process within the library, with a focus on availability first and foremost to students. The project team identified a number of goals for the project, such as meeting the library's commitment to introduce new and innovative technologies into the students' learning experiences, along with a determination to provide users with an option for mobile computing that went beyond traditional desktop or laptop computers. The selection of iPads was also influenced by a number of external factors outside the original scope of the project, including the fact that some faculty members and instructors were expressing an interest in tablets and ereader technologies, and that the university bookstore was independently exploring options for etextbooks. The timely release of the iPad commercially, and its potential for both general and educational use, presented an excellent opportunity to take this emerging technology into an academic setting.

Aims and Affordances

The methods discussed above for addressing the lack of evidence were useful in identifying how best to proceed, first by identifying outcomes and recognizing affordances, and then via a web-based environmental scan. Regarding affordances, the project team recognized that some characteristics of iPad technology could be easily matched to the expressed project outcomes, as illustrated in Table 1.

Table 1. Connecting affordance to outcome for iPads available via the library

Desired outcome	*Technological use or characteristic*
Provide mobile computing options for users to incorporate into their learning	Tablet computer with wireless Internet connection; mobility provides anytime, anywhere access
Improve access to ebooks and electronic scholarly resources and articles	Can be used as an ebook and PDF reader through web browser or downloadable applications
Make available to as many users as possible	Can be easily erased and restored through centralized account management, does not need to be attached to a single user

For instance, one driving factor of the project was the desire to improve access to the ebook and electronic article content available to users via the library's online resource collection. Since an iPad can be used as an ereader via the built-in web browser, via its ability to open common document formats including PDFs, and through the downloadable iBooks application, this technology provided multiple options for users seeking mobile access to ebooks and electronic articles.

Upon deeper examination of the technology under consideration, it became clear that the original iPads contained features that were similar to those found within existing ereader technologies. Recognizing this convergence, and identifying ereader affordances as important, led the project manager to consult existing literature about how various ereaders had been implemented in university and classroom settings. Ereaders had been commercially available in North America since as early as 2004, while popular devices including the Sony Reader, Amazon's Kindle, and Barnes & Noble's Nook ensured the adoption of ereader technology, and as such the project team had little trouble identifying various examples of how ereaders had been successfully implemented in classrooms and other academic settings. Now more informed about how those ereader devices had impacted pedagogically on learners and educators, particularly within the context of higher education settings and academic libraries, the project team then looked for other convergences. For example, the team recognized that some education institutions were using other Apple mobile devices, such as the iPhone and iPod Touch, in their classroom settings. Examining the formal and informal evidence base from those implementations provided additional insights regarding what we might expect from the iPad project.

Environmental Scanning

The other recommended method for addressing the lack of research evidence, conducting an environmental scan, proved invaluable for the success of the iPad project. Despite the novelty of iPads, web-based environmental scanning was

helpful in identifying other institutions that had implemented, or were in the process of implementing, projects also using iPads in their academic settings. As an information gathering process, this environmental scan relied upon general Internet searching using keyword searches in a search engine (e.g., targeted to find institutional materials, etc.), and returned an astounding number of hits that were not always specific to the project. Sifting through and assessing the results of this Internet search required patience on the part of those conducting the scan, a potential shortcoming of this type of information seeking behaviour mentioned above. However, by revealing where and how similar institutions were using iPads, especially those in academic library and university settings, the environmental scan itself was a worthwhile endeavour.

The compiled results of an environmental scan will look different for each project, but generally speaking should seek to document and categorize each scan result itself (and its source) for later reference, along with comments on the source's utility or application to the project at hand. As shown in Table 2, for the iPad project scan, results were categorized into two main types: primary sources (e.g., a website about an existing project) and secondary sources (e.g., a news site which mentioned a project), accompanied by a note on general information included in the result, and comments on the source's overall usefulness for the project at hand.

Table 2. Example – Documenting results of the iPad project environment scan

Scan source	*Category*	*Information revealed*	*Useful for local project?*
Project website	Primary	Existing and current iPad project at an academic institution; identifies aims and outcomes; logistical details outlined.	Yes, very. Logistical items and aims are of relevance to this project.
News story	Secondary	Mentions specific iPad project; gives details of student reception.	Yes. Details of student engagement especially helpful.
News story	Secondary	Convergent technology; broad discussion of ereaders in schools.	No. Not specific enough to project context or learning audience.
Academic article	Secondary	Convergent technology; discusses learning outcomes met by using ereaders.	Yes. Educational outcomes met by ereaders apply to iPads.

Note: Table data has been adapted for the purposes of this chapter (e.g., sources anonymized, etc.)

Sources categorized as "primary" are those which yielded the best results related to the iPad project, in that they typically identified existing and current iPad projects in a similar university setting. While information contained in the secondary sources

was less impactful to local implementation than primary sources, it was important to document and consult secondary sources that identified similar projects using the same technology or else a convergent technology, no matter whether those projects were in progress or under development. As discussed below, both primary and secondary sources may bear additional fruit. Information garnered from the iPad project environmental scan results included general details (such as over-arching project goals and desired outcomes), as well as project-specific details about other institutional iPad lending programs (such as logistical solutions that had yet to be resolved by the project team). These ES results proved to uncover unique and useful insights for the local project. Generating this informal evidence base about other, similar projects, also aided the team in developing successful implementation criteria at the host institution.

Though not specifically discussed above, we suggest that an important part of the environmental scan is to follow the most relevant sources as far as possible to their root. In the case of the iPad project, this meant contacting those responsible for the projects at similar institutions to informally discuss any methods and evaluation techniques not explicitly revealed by the environment scan results. The project lead contacted a number of institutions involved in similar iPad projects in an attempt to learn more about how those projects were implemented, how they were received by users, and what impact, if any, their respective projects had on the teaching and learning process, on service levels, and how those impacts were evaluated or assessed. Attempting contact in this manner had mixed results, as some respondents were more than happy to share their experiences, while others declined to share for various reasons. However, this measure is still worthwhile, since uncovering additional information from the respondents who did share insights with the project team in this case proved invaluable.

Overall, the small effort spent reaching out to other institutions paid large dividends when the project team was able to rely on this connection for sharing and discussing additional evidence. This extension of the environmental scan certainly bore additional fruit: in one instance an external contact not only provided information about their local project, but served as a secondary source, by pointing toward yet another institution which had not been discovered during the online search. Arguably, then, despite the ease of electronic environmental scanning via the Internet, human connections and contexts are still an important component of the environmental scan, and not to be ignored.

Case Study Summary

As this case study shows, the methods of i*dentifying goals and affordances* and *environmental scanning* have great potential for building and applying a useful informal evidence base, especially when also accounting for *convergence*. With regard to the iPad project, when applied in tandem, the information gathered during planning and early implementation more than accounted for the lack of formal

research evidence, assisting the project team in launching a successful project, as ultimately revealed by the measures used to evaluate the project. We recognize that the case study used to support the strategies was based on a specific project with a readily identifiable technology that would no longer be considered emergent (iPads are now mainstream technology). Nevertheless, we propose that the case study serves as a recent, practice-based example of how the methods discussed can be effective techniques for evidence gathering when considering how best to implement a new, emerging technology initiative in one's own educational setting.

CONCLUSION

Making decisions regarding the introduction of emerging educational technologies in learning environments is not always an easy task. However, the challenges presented with a perceived lack of up-to-date evidence regarding emerging technologies in educational practice may be mitigated through a reframing of these issues as wicked problems. There is value to be gained in widening the paradigmatic approaches to issues of evidence-based decision making beyond traditional positivistic lenses, to include alternative frameworks and viewpoints that are relational, iterative, and flexible, and take into account a range of viewpoints, contextually. We offer one example of an information gathering framework via the iPad case study, demonstrating a proposed approach that: (a) identifies aims and affordances, and (b) employs information seeking via environmental scanning to widen the available range of useful evidence and support informed decisions regarding emerging technologies.

As the case study illustrates, environmental scanning can take various forms depending on the goals, approaches, and disciplinary foci. For the purposes of integrating emerging technologies into pedagogical practice in the face of problems of evidence, the environmental scan is a carefully planned search to discover other instances where the new technology under consideration has been applied in a similar scenario, or failing that, instances where non-identical but similar technological affordances have been adopted in a pedagogical setting similar to that under consideration. Moreover, the environmental scan should be meaningful, taking into account the educator's original purpose for integrating the technology into practice. Finding an ideal or exact match is itself a challenge given the large amount of information available via multiple channels, such as the Internet. This is why it is of utmost importance to go beyond the extant formal research (or lack thereof), to carefully plan a wider analysis and engagement of additional empirical sources and observations, including sharing of information between institutions and educators.

As we look forward to the wicked problems posed by the educational and technological opportunities and issues of the future, a deeper discussion of the nature of technological or media convergence may broadly help to further build responsive and flexible approaches to such problems of evidence. Greater discussion of whether

there is, in fact, convergence apparent in the technologies at hand also works to widen our understanding of a long lineage of scholarship in instructional design and e-learning that can be leveraged today and in the future, including the rigorous and established research on similar affordances and patterns of interaction that are so often reflected in those technologies viewed as new or emerging.

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